FORM PTO-1390 (Modified) (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR)
211755US6PCT	09/869302

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/FR00/00101	19 JANUARY 2000	19 JANUARY 1999

TITLE OF INVENTION

SYSTEM FOR NEUTRALISING POLLUTANT GASES BY PYROLISIS

APPLICANT(S) FOR DO/EO/US

Claude ROUX

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include itens (5), (6), (9) and (24) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☒ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☐ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☐ Certificate of Mailing by Express Mail
23. ☒ Other items or information:

Request for Consideration of Documents in International Search Report
Notice of Priority
Drawings (4 sheets)

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/869302	PCT/FR00/00101	211755US6PCT

24. The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS PTO USE ONLY
☐	Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO $1000.00	
☒	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO $860.00	
☐	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO $710.00	
☐	International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) $690.00	
☐	International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) $100.00	

ENTER APPROPRIATE BASIC FEE AMOUNT =	**$860.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☒ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	**$130.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	- 20 =	0	x	$18.00	**$0.00**
Independent claims	- 3 =	0	x	$80.00	**$0.00**
Multiple Dependent Claims **(check if applicable).**				☐	**$0.00**

TOTAL OF ABOVE CALCULATIONS =	**$990.00**	
☐ Applicant claims small entity status. (See 37 CFR 1.27). The fees indicated above are reduced by 1/2.	**$0.00**	
SUBTOTAL =	**$990.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +	**$0.00**	
TOTAL NATIONAL FEE =	**$990.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐	**$0.00**	
TOTAL FEES ENCLOSED =	**$990.00**	
	Amount to be: refunded	$
	charged	$

a. ☒ A check in the amount of **$990.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **15-0030** A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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July 19 2001
DATE

211755US

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF :

CLAUDE ROUX : ATTN: APPLICATION DIVISION

SERIAL NO: 09/869,302 :

FILED: JULY 19, 2001 :

FOR: SYSTEM FOR NEUTRALISING POLLUTANT GASES BY PYROLISIS :

PRELIMINARY AMENDMENT

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

SIR:

Prior to a first examination on the merits, please amend the above-identified application as follows:

IN THE CLAIMS

1. (Amended) Pollutant neutralising system contained in gases emitted in particular by internal combustion engines including a pyrolitic heat cell arranged to retain and destroy pollutants, through means presenting a very large exchange area at the temperature of pyrolisis with the said pollutants; characterised in that the means of neutralising by pyrolisis presenting a very large exchange area with the said pollutants, comprises an assembly of spheres each containing, over its entire surface, numerous excrescences for example of diamond point or similar type.

3. (Amended) Pollutant neutralising system in accordance with claim 1, characterised in that the spheres each containing, over their entire surface, numerous excrescences of diamond point or similar type, are machined from limestone rock.

5. (Amended) Pollutant neutralising system in accordance with claim 1, characterised in that the spheres all containing, over their entire surface, numerous excrescences, for example of diamond point or similar type, are stamped as halves from a sheet of metal 0.4 mm thick and then welded together.

6. (Amended) Pollutant neutralising system characterised in that the pyrolitic heat cell for neutralising pollutants, containing means with a large exchange area with the said polluting gases, these means comprise a set of interchangeable electric heaters wound on themselves as flat spirals and stacked in an insulated chamber.

7. (Amended) Pollutant neutralising system in accordance with claim 1, characterised in that the exchange and pyrolisis surface of the pyrolitic heat cell comprise an assembly of hollow metal spheres furnished with excrescences filling its chamber.

8. (Amended) Pollutant neutralising system in accordance with claim 1, characterised in that the means presenting the exchange and pyrolisis surface of the heat cell comprise a set of mineral spheres furnished with excrescences, enclosed in a stainless steel net and put into the heat cell's chamber after the insertion of flat rings intended to fragment by impact large unburnt or partially burnt particles or HC, comprising a mesh of stainless steel swarf, preferably arranged ahead of the pyrolisis spheres.

Please add new Claims 9-16 as follows:

9. (New) Pollutant neutralising system in accordance with claim 2, characterised in that the spheres each containing, over their entire surface, numerous excrescences of diamond point or similar type, are machined from limestone rock.

10. (New) Pollutant neutralising system in accordance with claim 2, characterised in that the exchange and pyrolisis surface of the pyrolitic heat cell comprise an assembly of hollow metal spheres furnished with excrescences filling its chamber.

11. (New) Pollutant neutralising system in accordance with claim 3, characterised in that the exchange and pyrolisis surface of the pyrolitic heat cell comprise an assembly of hollow metal spheres furnished with excrescences filling its chamber.

12. (New) Pollutant neutralising system in accordance with claim 4, characterised in that the exchange and pyrolisis surface of the pyrolitic heat cell comprise an assembly of hollow metal spheres furnished with excrescences filling its chamber.

13. (New) Pollutant neutralising system in accordance with claim 5, characterised in that the exchange and pyrolisis surface of the pyrolitic heat cell comprise an assembly of hollow metal spheres furnished with excrescences filling its chamber.

14. (New) Pollutant neutralising system in accordance with claim 8, characterised in that the means presenting the exchange and pyrolisis surface of the heat cell comprise a set of mineral spheres furnished with excrescences, enclosed in a stainless steel net and put into the heat cell's chamber after the insertion of flat rings intended to fragment by impact large unburnt or partially burnt particles or HC, comprising a mesh of stainless steel swarf, preferably arranged ahead of the pyrolisis spheres.

15. (New) Pollutant neutralising system in accordance with claim 3, characterised in that the means presenting the exchange and pyrolisis surface of the heat cell comprise a set of mineral spheres furnished with excrescences, enclosed in a stainless steel net and put into the heat cell's chamber after the insertion of flat rings intended to fragment by impact large unburnt or partially burnt particles or HC, comprising a mesh of stainless steel swarf, preferably arranged ahead of the pyrolisis spheres.

16. (New) Pollutant neutralising system in accordance with claim 4, characterised in that the means presenting the exchange and pyrolisis surface of the heat cell comprise a set of mineral spheres furnished with excrescences, enclosed in a stainless steel net and put into the heat cell's chamber after the insertion of flat rings intended to fragment by impact large unburnt or partially burnt particles or HC, comprising a mesh of stainless steel swarf, preferably arranged ahead of the pyrolisis spheres.

IN THE ABSTRACT OF THE DISCLOSURE

Please cancel the original Abstract, page 14, in its entirety and insert therefor:

ABSTRACT OF THE DISCLOSURE

A system for neutralising polluting gases contained in particular in the exhaust gases of petrol or diesel internal combustion engines, or industrial smoke. The system includes modules assembled together or integrated, chosen in accordance with the quantity of pollutant gases and their nature. The assembled modules can include one or more of a hollow metal or mineral sphere-type pyrolisis heat cell module, containing excrescences forming a very large exchange area with polluting gases, or electric heaters, a particle and HC filter and polluting gas purification module, and a sound damping and gas temperature reduction module.

REMARKS

Favorable consideration of this application, as presently amended, is respectfully requested.

The present preliminary amendment is submitted to place the above-identified application in more proper format under United States practice. By the present preliminary amendment, the claims have been amended to no longer recite any multiple dependencies. The claims have also been amended to delete the term "consists" and recite the broader term "comprises". Further, the subject matter of the cancelled multiple dependencies is now set forth in new dependent Claims 9-16.

A new Abstract, believed to be in more proper format under United States practice, is also submitted herein.

The present application is believed to be in condition for a full and thorough examination on the merits. An early and favorable consideration of the present application is hereby respectfully requested.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, P.C.

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211755US

Marked-Up Copy
Serial No:
09/869,302
Amendment Filed on:
10-19-01

IN THE CLAIMS

--1. (Amended) Pollutant neutralising system contained in gases emitted in particular by internal combustion engines including a pyrolitic heat cell arranged to retain and destroy pollutants, through means presenting a very large exchange area at the temperature of pyrolisis with the said pollutants; characterised in that the means of neutralising by pyrolisis presenting a very large exchange area with the said pollutants, [consists of] comprise an assembly of spheres each containing, over its entire surface, numerous excrescences [(1, 2, 3)] for example of diamond point or similar type.

3. (Amended) Pollutant neutralising system in accordance with [claims 1 and 2] claim 1, characterised in that the spheres each containing, over their entire surface, numerous excrescences of diamond point or similar type, are machined from limestone rock.

5. (Amended) Pollutant neutralising system in accordance with claim 1, characterised in that the spheres all containing, over their entire surface, numerous excrescences, for example of diamond point or similar type, are stamped as halves [(6, 7)] from a sheet of metal 0.4 mm thick and then welded together.

6. (Amended) Pollutant neutralising system characterised in that the pyrolitic heat cell for neutralising pollutants, containing means with a large exchange area with the said polluting gases, these means [consist of] comprise a set of interchangeable electric heaters [(32)] wound on themselves as flat spirals and stacked in an insulated chamber [(30)].

7. (Amended) Pollutant neutralising system in accordance with [claims 1 and 5] claim 1, characterised in that the exchange and pyrolisis surface of the pyrolitic heat cell [(38)] [consists of] comprise an assembly of hollow metal spheres [(7)] furnished with excrescences [(1, 2 or 3)] filling its chamber [(39)].

8. (Amended) Pollutant neutralising system in accordance with [claims 1 to 4] claim 1, characterised in that the means presenting the exchange and pyrolisis surface of the heat cell [(44)] [consists of] comprise a set of mineral spheres furnished with excrescences [(1, 2 or 3)], enclosed in a stainless steel net [(47)] and put into the heat cell's chamber [(45)] after the insertion of flat rings [(50, 51)] intended to fragment by impact large unburnt or partially burnt particles or HC, [consisting of] comprising a mesh of stainless steel swarf, preferably arranged ahead of the pyrolisis spheres.

Claims 9-16 (New).--

IN THE ABSTRACT OF THE DISCLOSURE

(New).

4 / PRTS

System for neutralising pollutant gases by pyrolisis

The invention concerns a system for neutralising pollutant gas by the pyrolisis of particles and soot in suspension, emitted in particular by petrol or diesel internal combustion engines, or by all types of industrial combustion emitting noxious smoke, for example waste incineration plants.

It is known in particular that the combustion of fuels feeding petrol or diesel internal combustion engines can never be balanced and complete in particular because of a lack of air at the transient instant and the presence mainly of noxious substances in the exhaust gas such as carbon monoxide CO, unburnt or partially burnt hydrocarbons HC, nitrogen oxides NO_x and solids such as particles and soot. The appearance of particles and soot results from carburetion with too little air. It occurs notably at transients: moving off when traffic lights change to green, changes of speed on the level, on hills and when accelcrating.

Systems are already known for processing these pollutants such as "catalytic converters on cars and more recently on diesel lorries, employing catalysts designed to oxidise mainly the carbon monoxide, unburnt or partially burnt hydrocarbon residues and nitrogen oxide NO_x. The drawbacks shown by this type of system lie in particular in the difficulty of choosing an effective metal or metal oxide catalyst to accelcrate these reactions. A catalyst that reduces the NO_x beyond N_2, into N_3H, is not suitable because the ammonia released into the atmosphere re-oxidises into NO_x. Another important drawback of this system appears when an internal combustion engine starts from cold until the catalytic converter reaches optimal running temperature. During this period, emissions of pollutants not only are not reduced, but are increased. This drawback requires costly, noble metals to be chosen such for example as platinum which acts at low temperature. In addition, the sulphur SO_2 in petrol is oxidised into SO_3 by the catalyst, which generates sulphuric acid. In general, catalytic converters are very expensive, reduce engine power, increase fuel consumption by adding an additional weight to the vehicles empty weight, they only neutralise part of the pollutants and their effectiveness is limited. As regards "gas washing" processes, they are excessively costly.

Systems designed to destroy by combustion the particles in the polluting exhaust emitted from diesel engines are also known. This combustion allows toxic carbon residues to remain. Particle filters are also known, but they block very quickly and need to be changed or a regeneration system to be added which increases the cost.

Document WO 92 14042 A describes a polluting gas neutralisation system consisting of a pyrolisis heat cell arranged to retain and destroy residues from incomplete combustion by means of presenting a large exchange area.

Document RF-A-2 702 004 mentions that on heat destruction by pyrolisis of residues from incomplete combustion, that they are only partly oxidised which produces dust. It also mentions a means of noise abatement during the pyrolisis of residues from incomplete combustion.

Document DE 14 76 627 A discloses a filtration device combining filtering units (37, 44, 46) and noise abatement units.

Document GB-A-1 396 607 describes a polluting gas neutralisation system consisting of a pyrolisis heat cell consisting of an interchangeable linear electric heater assembly (26a to 26 c) spanning the heat cell between insulating plates (45). The exchange area of these heating elements with the pollutants crossing the heat cell is low and not very efficient.

Document WO 90 04 707 describes a polluting gas neutralisation system consisting of a stack of metal plates each of them carrying on its surface multiple excrescences, the said plates being coiled in a spiral and inserted into the chamber of a cylindrical pyrolisis heat cell. The said plates can be run as electrical heaters.

The problem to be solved consists particularly of:

- providing a simple, durable system considerably reducing the emission of polluting gases from internal combustion engines and from various factories, to a level very much lower than those already obtained by existing systems meeting the strictest standards;
- providing the system at a cost equal and preferable less than that of traditional means of equal effectiveness;

- not introducing any loss of power that increases fuel consumption and reduces power in the case of internal combustion engines;
- substantially increasing the life of the system;
- reducing the emission of polluting gasses from various industrial processes (waste incineration plants, oil fired municipal heating or even domestic oil fired heating and all types of emissions of noxious smoke containing various particles in suspension that can be destroyed by pyrolisis).

The system according to the invention is intended to counter the aforementioned drawbacks, solve the problem posed above and provide a range of means of effectively reducing pollutants emitted by diesel or petrol internal combustion engines, covering a broad part of the power range of existing fixed or mobile engines on the market, the system being adaptable to the pyrolisis of industrial smoke.

The system according to the invention consists of a means of neutralising polluting gases consisting of a pyrolisis heat cell arranged to retain and destroy the residues from incomplete combustion, by the intermediary of means presenting a very large exchange area at pyrolisis temperature with the said gases. The said exchange and pyrolisis area being made to almost instantly reach the temperature of the said exhaust gases once the internal combustion engine is started up.

Under a first method of construction, the exchange and pyrolisis area consists of a set of spheres each containing, over its entire surface, numerous excrescences (1, 2, 3) for example of diamond pointed type or similar. The spheres, each bearing numerous excrescences, are machined from limestone or any other kind of rock. The spheres can also be obtained by moulding mineral powder, preferably limestone.

The spheres with their excrescences can be stamped out as two welded parts, from a metal with a high coefficient of heat transmission, as sheets of very low thickness. The spheres are processed to size and put into a pyrolisis heat cell of corresponding size.

In accordance with a second variant of construction, the means of neutralising polluting gases presenting a very large exchange area consists of a stack of very thin metal plates of high coefficient of heat transmission, each carrying, over its entire area, numerous preferably identical excrescences,

stamped staggered compared to the gas flow direction. These pyrolisis plates are put into an insulated heat cell of rectangular or square section.

In accordance with a third variant of construction, the means of neutralising polluting gases presenting a very large exchange area consists of a single pyrolisis plate wound as a spiral and put into the chamber of an insulated cylindrical heat cell. The spiral plate is brought up to temperature by switching it on just before the engine is started up, by using it as an electrical heater.

In accordance with a fourth variant of construction, the means of neutralising polluting gases consists of a set of interchangeable electrical heaters wound flat as spirals and stacked in an insulated enclosure. The pyrolisis exchange area is brought up to temperature, when the engine is started up, by a discharge from condensers of adequate capacity. To prevent heat losses, the pyrolisis heat cell is arranged as close as possible to the engine and is fully insulated as is the exhaust gas pipe between the internal combustion engine and the said pyrolisis heat cell.

The system according to the invention consists of modules assembled together or integral, chosen in accordance with the amount and type of polluting gases, from some or all of the following modules: pyrolisis heat cell module, particle and HC filtration and polluting gas purification module, silencer and gas temperature reduction module.

For high or very high quantities of polluting gasses, the pyrolisis function is provided by a battery of heat cells containing an input collector and an output collector which, when necessary, work together with a smoke extractor.

The advantages of the present invention are as follows:

- Very substantial reduction in polluting gases;
- Longer life than traditional exhaust converters because of the absence of water vapour and continuous regeneration by vibration of the pyrolisis heat cell;
- Possibility of making very compact extra-thin systems for all engine powers;
- No loss of engine power;
- No excess fuel consumption;
- Little added weight compared to traditional exhaust converters;

- Is operational from when the engine starts up;
- Suitable for all stationary engines
- Can be used for reducing industrial smoke and smoke from oil central heating facilities.

The invention is described in detail in the text below, in reference to the appended drawings that are provided as non-limiting examples, in which:

- figures 1 to 4 show diagrammatic examples of means of producing the pseudo-spherical exchange and pyrolisis surfaces of the system according to the invention for a diesel or petrol engine;
- figures 5, 6 and 7 show diagrammatic cross-section examples of the pseudo-flat exchange and pyrolisis surfaces of the system according to the invention for a diesel or petrol engine;
- figure 8 shows, seen from above, a diagrammatic example of the arrangement of the hemispherical or cylindrical excrescences as in figures 6 and 7 intended to retain and heat unburnt or partly burnt particles or HC of the system according to the invention;
- figure 9 shows, seen from above, a diagrammatic example of the arrangement of the excrescences known as diamond point as in figure 5 intended to retain and heat unburnt or partly burnt particles or HC of the system according to the invention;
- figure 10 partially shows a diagrammatic example of the stacking of thin metal plates bearing cylindrical excrescences intended to retain and heat unburnt or partly burnt particles or HC of the system according to the invention;
- figure 11 shows diagrammatically the spiral winding of a thin metal plate bearing excrescences intended to retain and heat unburnt or partly burnt particles or HC of the system according to the invention;
- figures 12 and 13 show a diagrammatic example of the construction of an exchange and pyrolisis surface consisting of a set of electrical heater elements wound in a flat spiral, as front view and side view cross-sections;
- figure 14 shows diagrammatically, as a front view cross-section, an example of the construction of the exchange and heating surface consisting of a set of hollow metal spheres, bearing excrescences, in place in a sealed, insulated chamber;

- figure 15 shows diagrammatically, as a front view cross-section, an example of the construction of the exchange and pyrolisis surface consisting of a set of mineral metal spheres bearing excrescences, in place in a scaled, insulated chamber after placement between them of a metal sock and flat rings consisting of stainless steel swarf;
- figures 16 and 17 show diagrammatically, as an end cross-section and as a front view cross-section, an example of the heating heat cell containing exchange and heating surfaces consisting of a set of plates bearing excrescences, in place in a sealed, insulated chamber;
- figure 18 shows diagrammatically, as a front view, an example of the known type of catalytic converter;
- figure 19 shows diagrammatically, as a front view, an example of the complete pyrolisis converter in accordance with the invention for heavy goods vehicles, buses and coaches, heavy plant, etc.;

As shown in **figures 1 to 3**, the example of the large exchange and pyrolisis surface in accordance with the invention to dry exhaust gases, retain and quickly pyrolise unburnt or partially burnt particles and HC, consists of excrescences machined on the surface of mineral spheres. The shape of these identical excrescences is preferably one that offers the greatest exchange area with the gases. They may, for example, be "diamond pointed" 2, more keenly pointed 1 (Isosceles pyramids) or hemispherical 3 or other shapes easy to achieve by machining or moulding mineral dust such as limestone under pressure. By moulding, it is possible to get other shapes bearing these excrescences other than spheres, but spheres are preferable because they provide the greatest exchange area at equal volume and facilitate the circulation of gases.

Figure 4 shows an example of the hollow sphere made of thin metal, about 4 mm thick, bearing diamond pointed excrescences, stamped in halves (6 and 7) and electric or ultrasonic welded for example. The material is to be chosen from ones providing the best coefficient of heat transmission and corrosion-resistance to exhaust gasses and other toxic emissions. As an example, the diameter of the spheres is around 20 mm for cars, 50 mm for

coaches and 60 mm for heavy goods vehicles. The quantity of spheres depends on the throughput of pollutants to be neutralised.

The primary function of the excrescences is to reduce the thermal inertia of the surface of the spheres such that they almost instantly reach the temperature of the exhaust gases once the internal combustion engine is started up, it not being necessary to heat the spheres right through to be effective. They form a mass of accumulated heat. The secondary function of the excrescences is to increase the exchange area with the gases and retain passing unburnt or partially burnt particles and residues that adhere to the excrescences more readily with diminishing size and heat more quickly. The third function of the excrescences is to facilitate the throughput of gases by preventing the occurrence of a loss of charge reducing the power of the engine.

The pyrolisis of particles and soot considerably reduces their volume, or even makes them almost totally disappear. After pyrolisis, particle residues no longer contain toxic carbon CO which is converted into non-toxic CO_2. HC are also converted by the pyrolisis and become harmless. The water H_2O produced by combustion of the fuel is eliminated on passing through the spheres. The very low particle and HC residues end up by being released due to the vibrations caused by driving and gasses moving through, which continuously regenerates the exchange surfaces. This very low volume of residues is driven by the pressure of the gases into the following filter part.

Hollow mineral or metal spheres represent a first means of producing the exchange and pyrolisis surface. In the specific case of large diameter spheres, the throughput apertures between the spheres are large and liable to allow un-neutralised or insufficiently neutralised particles and soot to pass.

Figures 5 to 11 show another model for producing very large exchange surfaces much more compact and regular than with spheres. Figures 5, 6 and 7 show examples of excrescences of various known shapes on spheres: diamond pointed 10, hemispherical 11 or cylindrical 12, stamped on flat surfaces, preferably arranged as a mesh 15 staggered in accordance with an angle for example of 45° compared to the direction 16 of gas flow, to avoid direct tunnels.

The staggered arrangement makes the gases follow a route including a number of obstacles against which particles and soot are thrown and fragment because of the impact due to the speed of the gases, mainly at the start of the circuit reducing their size and adhering to the excrescences at a temperature of around 800 to 900 degrees C, on which they are converted chemically and reduced to inert residues of very low volume. The length of travel of the gases in the pyrolisis heat cell is arranged such that almost all of the particles and soot are neutralised. These low residues then detach because of vibration and are then removed by the pressure of the gases in the following filter.

Figure 9 shows an example of the arrangement of the excrescences stamped as diamond points on a plate 20. The diamond points are arranged such that no flat parts remain on the plate 20 except locally at the edges.

This arrangement provides the largest possible exchange surface while allowing vibration to be limited. In the instance of diamond points, some of them have been omitted from place to place to allow them to be stacked by allowing a space to remain of point height for gases to circulate. The height of the points or excrescences is calculated in accordance with the maximum throughput of exhaust gases to prevent load losses.

Figure 10 shows a partial stack of pyrolisis plates with closed cylindrical shaped excrescences 12 arranged staggered intended to completely fill the pyrolisis heat cell.

Figure 11 shows an example of the cylindrical pyrolisis heat cell 21 consisting of a pyrolisis plate 22 in figures 5, 6 or 7, wound with no centre and banded, put into the chamber 23 of the heat cell containing insulation 24, onto which the roll is located by force, or is enclosed in a stainless steel sock 25 before it is put into the heat cell. The structure of the heat cell is identical to that of the heat cells in the following figures.

Figures 12 and 13 show diagrammatically a front cross-section and side cross-section of an example of the pyrolisis heat cell 29 consisting of a cylindrical chamber 30 wrapped with insulating material 31, in which a set of identical electric heaters is arranged 32 wound in a flat spiral fitted with a space 33 between them. The electric heaters can be assembled in various known ways.

The gas inlet 34 and outlet 35 closure flanges preferably form a cone opening onto the gas inlet 36 and outlet 37 pipes. The well known electrical insulation and skin bushing method is not shown. The temperature of the heaters is calibrated in accordance with the nature of the pollutants to be reduced by pyrolisis. The number of heaters and diameter of the heat cell depend on the throughput of gas. For maintenance, this type of heat cell is fitted with interchangeable heaters. Each ceramic ring carrier for a heater with its usual means of fixing, contains for example two shoulders the reverse way around, which enables them to be successively seated. The heaters are connected for example by terminals. The insulated chamber can be made as two half shells so can be dismantled and faulty heaters changed.

This type of heat cell can be used for a large number of industrial applications independent of the pyrolitic exhaust gas converter application for internal combustion engines, in particular for large oil-fired heating plants that also emit a lot of soot and notably contribute to urban pollution. For very high outputs of industrial smoke, for example from waste incineration plants, batteries of pyrolitic heat cells can be installed with an inlet collector and an outlet connector, working with a smoke extractor to prevent back pressure when outlet speed is low.

The benefit of this type of heat cell lies in the fact that it is possible to accurately control the temperature of pyrolisis as required.

Figure 14 shows diagrammatically a front cross-section of an example of the cylindrical pyrolisis heat cell 39 enclosed in insulation 40, whose exchange surface consists of a set of hollow metal spheres 7 bearing excrescences, previously adjusted to the size of the heat cell in a stainless steel net, located by crimping the closure skin 41 or 42. The number and diameter of the spheres and diameter and length of the heat cell depend on the quantity and nature of the gases (petrol, diesel or others in applications other than engines).

Figure 15 shows diagrammatically a front cross-section of an example of the cylindrical pyrolisis heat cell 44 containing a sealed skin 45 enclosed in insulation 46, whose exchange surface consists of a set of mineral spheres 1, 2 or 3, carrying excrescences, previously adjusted to the size of the heat cell in a stainless steel net, and inserted in a sock 47, located before crimping of the closure skin 48 or 49 after insertion of flat rings 50, 51 consisting of a meshed stainless steel wire, presenting in cross section three very sharp edges, also previously enclosed in a stainless steel net. The particles and soot are fragmented by impact on its successive edges through its meshing in the flat ring. The wire can be obtained in the form of continuous lathe swarf. It is then meshed. Because of its nature, the flat ring acts as a sound damper to lower the noise level of the exhaust gases.

The number and diameter of the spheres and the length and diameter of the heat cell depend on the quantity of gases and their nature (petrol, diesel or others in applications other than vehicle engines).

Figures 16 and 17 show diagrammatically an end cross-section and front cross-section of another example of the pyrolisis heat cell 55 containing exchange surfaces consisting of a set of pyrolisis plates 56 in accordance with one of the figures 5, 6 or 7, bearing excrescences 10, 11 or 12, in place in a sealed chamber 57 surrounded by insulation 58 of rectangular cross-section; consisting of a gas inlet pipe 59 and outlet pipe 60 offset in relation to one another. This type of pyrolisis heat cell is much more compact than sphere-type pyrolisis heat cell because the entire volume is used for exchange with the gases, which is not the case with the volume within the spheres.

Figure 18 shows a traditional catalytic converter configuration consisting of a catalyst module 65, an intermediate filter module 66 and a noise damping silencer module 67.

Figure 19 shows diagrammatically the fullest configuration of the system in accordance with the invention for high powered engines. This configuration consists of modules assembled with one another by crimping their inlet pipe and outlet pipe. The same type of module can be produced according to a range of different lengths and/or cross-sections, which enables systems to be made to suit the throughput, the nature of gases and density of their load of particles or soot to be heated, for

predetermined power ranges, by the choice of some or all of the following modules: a neutralisation by pyrolisis module 70.

The function of the filter module can also be provided for example by an accordion carbon filter-type paper also enclosed in a stainless steel net. The job of the volume of the carbon filter is to retain the very fine pyrolisis residues from the previous means, to continue the reduction of residual gaseous components that they may contain, and to purify residual gaseous pollutants as they pass through, to continue their neutralisation; a deodorising and neutralising gas injection module 72.

CLAIMS:

1) Pollutant neutralising system contained in gases emitted in particular by internal combustion engines including a pyrolitic heat cell arranged to retain and destroy pollutants, through means presenting a very large exchange area at the temperature of pyrolisis with the said pollutants; characterised in that the means of neutralising by pyrolisis presenting a very large exchange area with the said pollutants, consists of an assembly of spheres each containing, over its entire surface, numerous excrescences (1, 2, 3) for example of diamond point or similar type.

2) Pollutant neutralising system in accordance with claim 1, characterised in that the spheres all containing, over their entire surface, numerous excrescences of diamond point or similar type, are machined from rock of any kind whatever.

3) Pollutant neutralising system in accordance with claims 1 and 2, characterised in that the spheres each containing, over their entire surface, numerous excrescences of diamond point or similar type, are machined from limestone rock.

4) Pollutant neutralising system in accordance with claim 1, characterised in that the spheres all containing, over their entire surface, numerous excrescences of diamond point or similar type, are moulded from limestone mineral powder.

5) Pollutant neutralising system in accordance with claim 1, characterised in that the spheres all containing, over their entire surface, numerous excrescences, for example of diamond point or similar type, are stamped as halves (6, 7) from a sheet of metal 0.4 mm thick and then welded together.

6) Pollutant neutralising system characterised in that the pyrolitic heat cell for neutralising pollutants, contains means with a large exchange area with the said polluting gases, these means consist of a set of interchangeable electric heaters (32) wound on themselves as flat spirals and stacked in an insulated chamber (30).

7) Pollutant neutralising system in accordance with claims 1 and 5, characterised in that the exchange and pyrolisis surface of the pyrolitic heat cell (38) consists of an assembly of hollow metal spheres (7) furnished with excrescences (1, 2 or 3) filling its chamber (39).

8) Pollutant neutralising system in accordance with claims 1 to 4, characterised in that the means presenting the exchange and pyrolisis surface of the heat cell (44) consists of a set of mineral spheres furnished with excrescences (1, 2 or 3), enclosed in a stainless steel net (47) and put into the heat cell's chamber (45) after the insertion of flat rings (50, 51) intended to fragment by impact large unburnt or partially burnt particles or HC, consisting of a mesh of stainless steel swarf, preferably arranged ahead of the pyrolisis spheres.

SUMMARY

The invention concerns a system for neutralising polluting gases contained in particular in the exhaust gases of petrol or diesel internal combustion engines, or industrial smoke. It consists of modules assembled together or integrated, chosen in accordance with the quantity of pollutant gases and their nature, from among some or all of the following modules: hollow metal or mineral sphere-type pyrolisis heat cell module (70), containing excrescences forming a very large exchange area with polluting gases, or electric heaters; particle and HC filter and polluting gas purification module (71), sound damping and gas temperature reduction module (73).

Summary drawing figure 19.

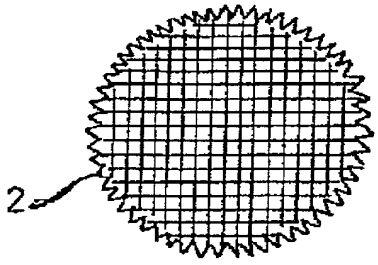
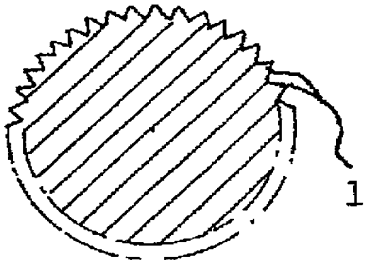


FIG. 1



F I G. 2

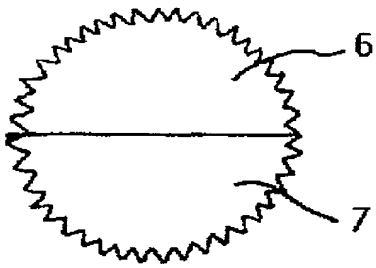


FIG. 4

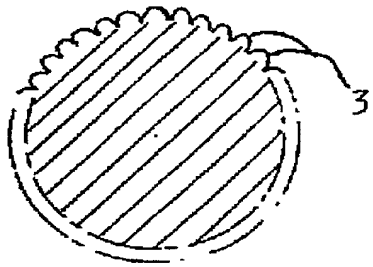


FIG. 3

FIG. 5

FIG. 6

FIG. 7

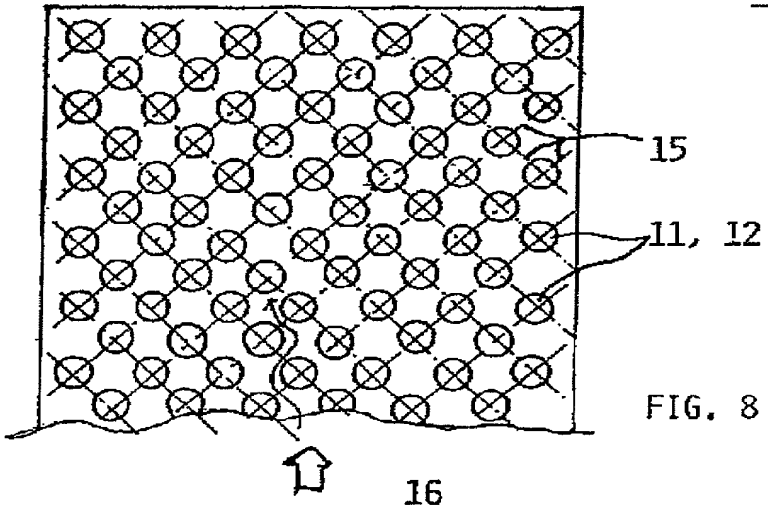


FIG. 8

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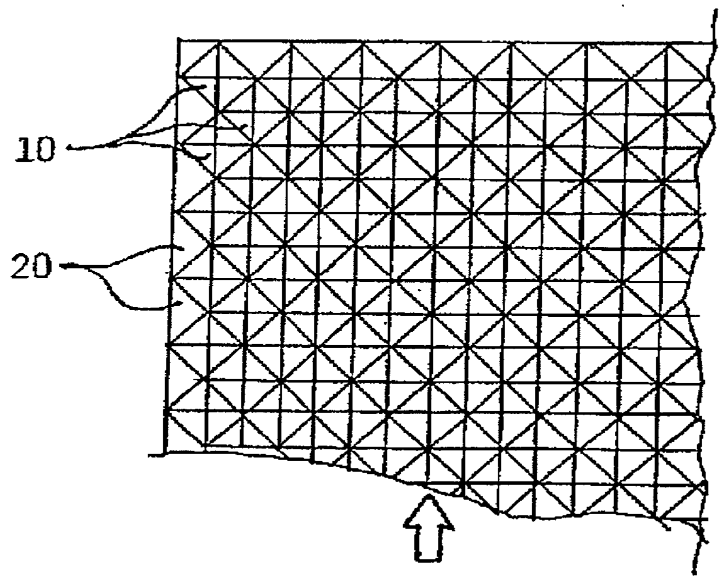

FIG. 9

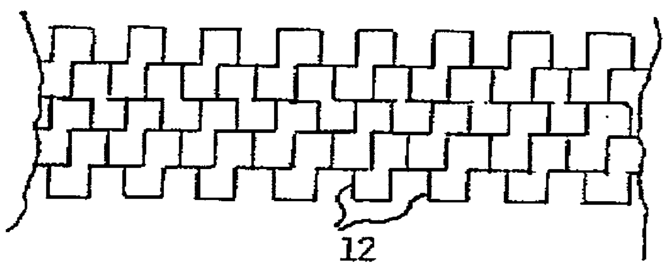

FIG. 10

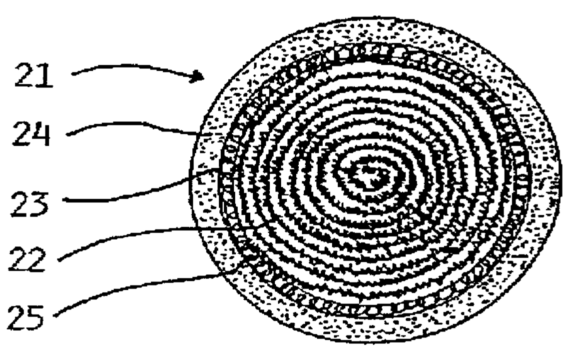

FIG. 11

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FIG. 12

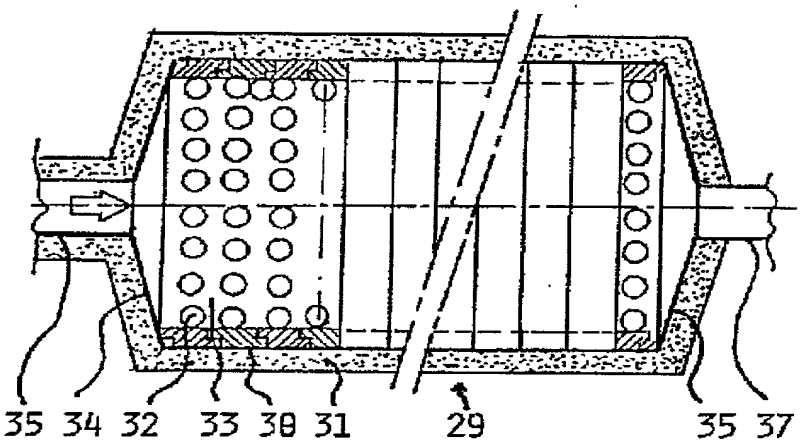


FIG. 13

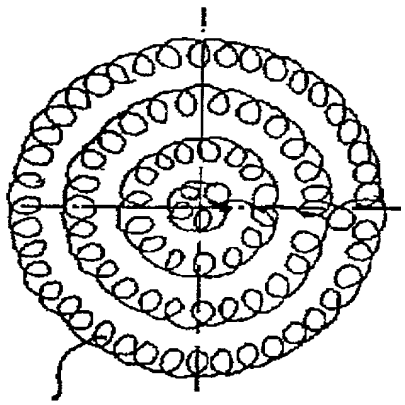


FIG. 14

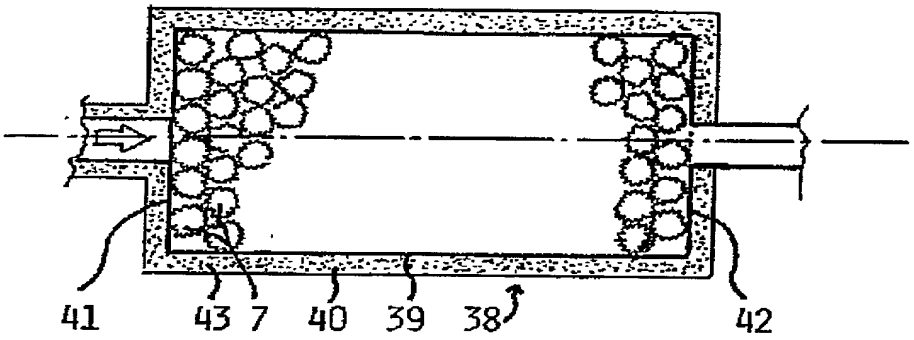


FIG. 15

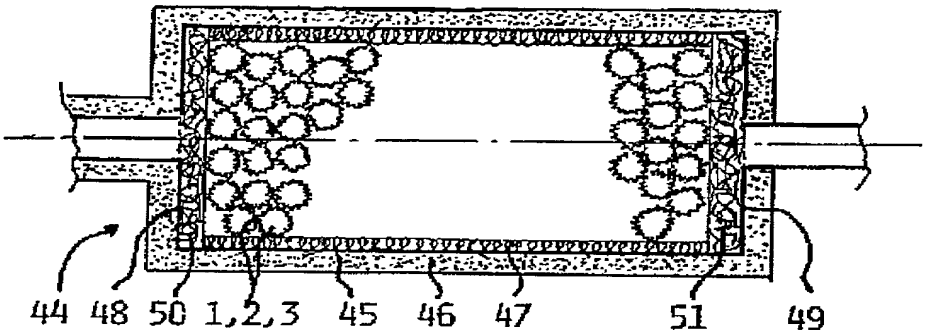
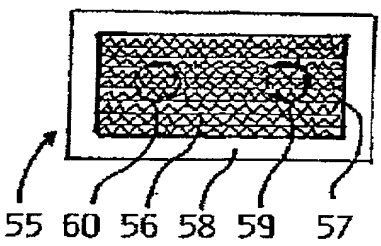


FIG. 16



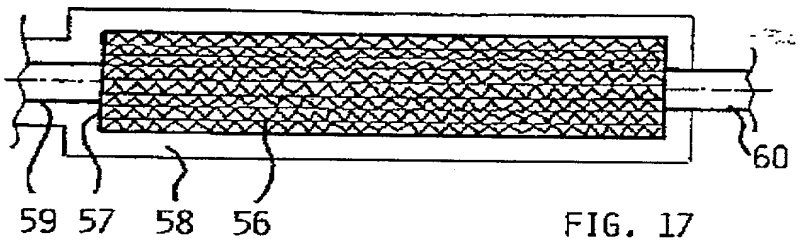


FIG. 17

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FIG. 18

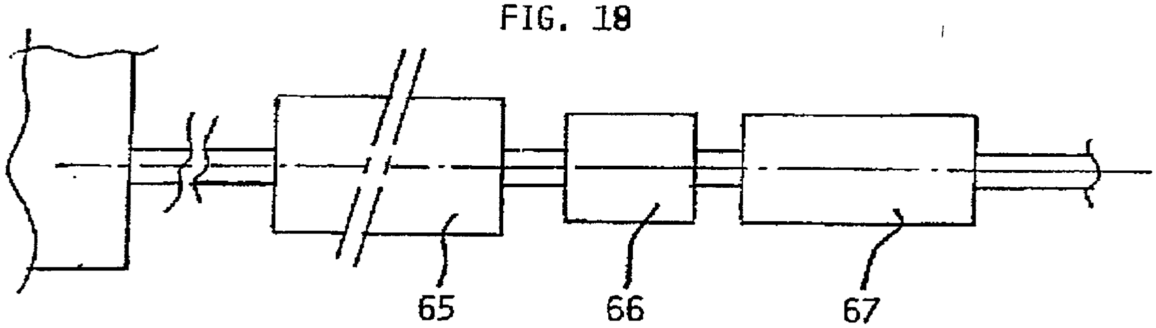
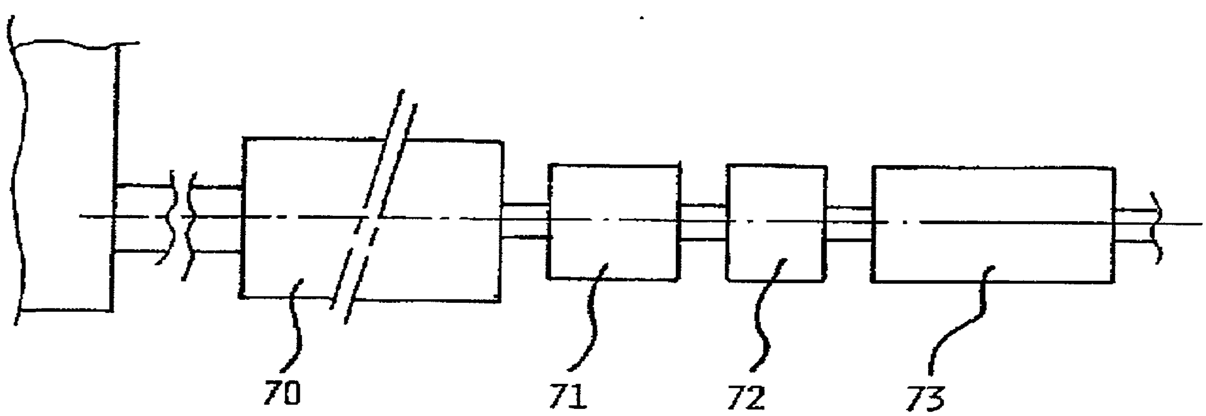


FIG. 19



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Declaration, Power Of Attorney and Petition

WE (I) the undersigned inventor(s), hereby declare(s) that:

My residence, post office address and citizenship are as stated below next to my name,

We (I) believe that we are (I am) the original, first, and joint (sole) inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention entitled

SYSTEM FOR NEUTRALISING POLLUTANT GASES BY PYROLISIS

the specification of which

☐ is attached hereto.

☒ was filed on 19 JULY 2001 as

Application Serial No. 09/869,302

and amended on _____.

☒ was filed as PCT international application

Number PCT/FR00/00101

on 19 JANUARY 2000,

and was amended under PCT Article 19

on _____ (if applicable).

We (I) hereby state that we (I) have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

We (I) acknowledge the duty to disclose information known to be material to the patentability of this application as defined in Section 1.56 of Title 37 Code of Federal Regulations.

We (I) hereby claim foreign priority benefits under 35 U.S.C. § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed. Prior Foreign Application(s)

Application No.	Country	Day/Month/Year	Priority Claimed
99/00483	FRANCE	19 JANUARY 1999	☒ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No

We (I) hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below.

(Application Number) (Filing Date)

(Application Number) (Filing Date)

We (I) hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s), or under § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

Application Serial No.	Filing Date	Status (pending, patented, abandoned)
PCT/FR00/00101	19 JANUARY 2000	

And we (I) hereby appoint the following registered practitioner(s):

022850

as our (my) attorneys, with full powers of substitution and revocation, to prosecute this application and to transact all business in the Patent Office connected therewith; and we (I) hereby request that all correspondence regarding this application be sent to

022850

We (I) declare that all statements made herein of our (my) own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Claude ROUX
NAME OF FIRST SOLE INVENTOR

Signature of Inventor

Date

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FRANCE

Citizen of: FRANCE

Mailing Address: SAME AS ABOVE

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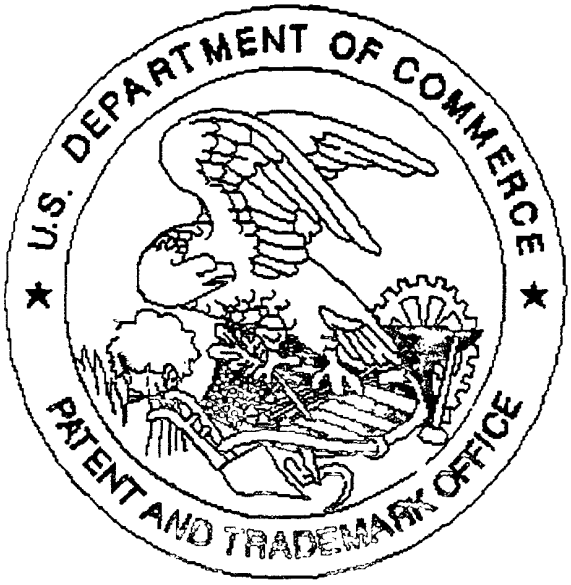

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